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Chicago, Illinois, October 8-13, 1995

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A sensor which is capable of detecting hydrocarbons and distinguishing among them at temperatures in the range 100- 500"C has been constructed from 6H-silicon carbide and tested in methane and propene. The active layer on the sensor is photoelectrochemically etched porous silicon carbide. Experimental data show that it is possible to detect the presence of the two hydrocarbon gases as pure gas or as 0.5% hydrocarbon in argon, and to distinguish between them.

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A Variable Potential Porous Silicon Carbide Hydrocarbon Gas Sensor

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A sensor which is capable of detecting hydrocarbons and distinguishing among them at temperatures in the range 100- 500°C has been constructed from 6H-silicon carbide and tested in methane and propene. Experimental data show that it is possible to detect the presence of the two hydrocarbon gases and to distinguish between them.

The ability to detect hydrocarbon and other organic vapors with a small, lightweight sensor made from silicon carbide has several applications and advantages. Such an ability would be desirable to monitor the constituents in the exhaust stream of an engine, to monitor the atmosphere in an enclosed area which depends *on* cleaning recirculated air for breathing, or for use in monitoring functions in various process industries. Silicon carbide is a robust semiconducting material which may be operated at temperatures substantially higher than operating temperatures for silicon.

Semiconductor based sensors such as those made from SnO_2 are well known, and are capable of detecting oxygen containing compounds such as CO and CO_2 as well as hydrogen containing compounds such as NH, and H_2 [1]. Such sensors are also able to detect hydrocarbon compounds, but are not able to distinguish among them. Recent developments in silicon carbide material growth technology make it possible to construct sensors using SiC as the electronic material as well as the active material in a gas sensor. The importance of SiC is based upon its ruggedness, durability, and relatively low cost, as well as its potential for use at high temperature (much greater than 33(Y'C) and power levels.

A capacitor-type sensor based on a catalytic surface attached to a SiC substrate has been constructed and tested by Arbab *et al.* [2]; that sensor requires high temperatures (> 500°C) for catalysis, and it is not clear that the sensor is able to distinguish among hydrocarbon compounds in the gas stream.

The sensor to be discussed here is made from hexagonal (6H) silicon carbide, and includes a layer of porous SiC on the bulk SiC; it has been tested in argon, methane and propene. A chromium grid was evaporated on the porous layer to provide an equipotential contact and a path' for the diffusion of gas into the **sensor** while a nickel contact was deposited on the unetched side of the SiC wafer. Experiments show the sensor's ability to distinguish among an inert gas, argon, and the two hydrocarbons methane and propene. Experiments *in streams* of the pure gases showed non-linear, reproducible differences in current-voltage curves, run from -7 to 7 V across the device. Figure 1 shows a plot of the current differences between methane and propene, normalized to the argon response, thus eliminating pure resistive effects in the current-voltage curves. Experi mental evidence of the ability to distinguish among gases in mixed streams will also be presented. The discriminating ability of this sensor has been demonstrated both in pure gas and in low concentrations (0.5 %) of gas in argon.

The operation of the SiC sensor is based on adsorption and reaction of hydrocarbon in a layer of porous or of polycrystalline SiC. The use of silicon carbide allows the gas sensor to function at high temperatures such as those typically found in automotive exhaust streams; however, testing has shown that the sensor may also be operated at substantially lower temperatures, and so it may be used in lower temperature applications such as monitoring the composition of breathing air. The mechanism of operation is not yet understood; it may operate based on dissociation of the hydrocarbons, where different weights and bond strengths determine the potential at which dissociation occurs, Alternatively, or perhaps additionally, the sensor may operate as an electrochemical device in which the hydrocarbon is oxidized at the surface at its oxidation potential or by a change in surface capacitance or resistance owing to adsorption of organic molecules, In either mechanism, the hydrocarbon, or perhaps class of hydrocarbons, is identified by the potential at which the sensor responds.

The present example being tested at JPL is configured as a simple vertical construction of 6H-SiC with a porous layer as an active layer. It is possible that addition of a catalyst may add specificity or range by influencing the mechanism. Such questions will be addressed in this talk.

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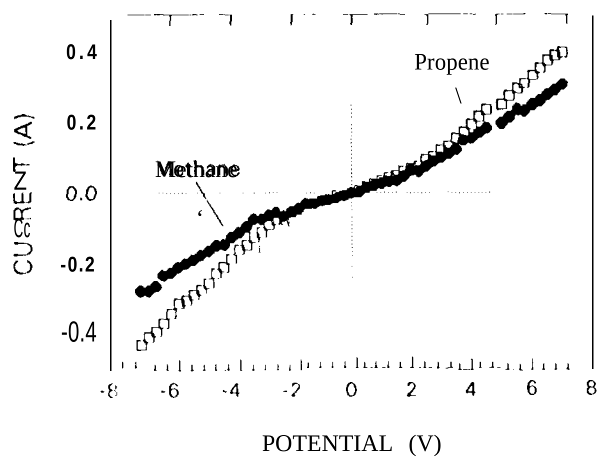

Figure 1: The iV curve of pure methane and pure propene on the SiC sensor strews a clear difference in response. The argon response is subtracted from the hydrocarbon response in this plot.